Elliptic Flow Analysis in ALICE

Naomi van der Kolk ~ *kolk@nikhef.nl*

NIKHEF

Elliptic flow

In non-central heavy ion collisions the overlap region is asymmetric. Observables, like collective motion and medium modification of jets, become azimuthally dependent.

The azimuthal dependence of particle production can be characterized by a Fourier expansion:

$$E \frac{d^3N}{dp_x dp_y dp_z} = \frac{1}{2\pi} \frac{dN}{p_t dp_t dy} \left(1 + \sum_{n=1} 2v_n \cos\left(n\left[\varphi - \Psi_R\right]\right) \right)$$
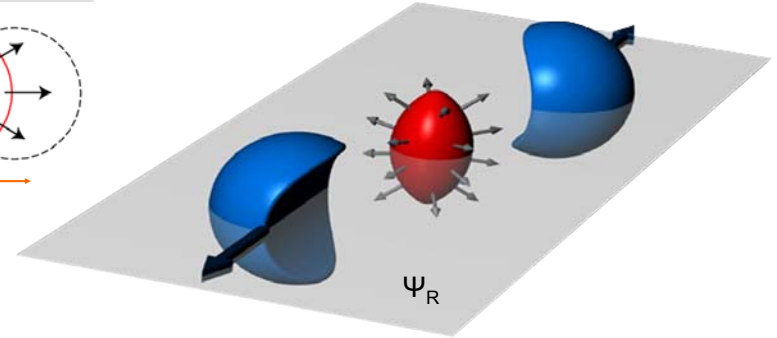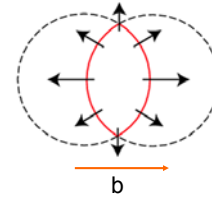
Coefficients v_n Reaction plane angle

v_2 is the most dominant contribution to the azimuthal dependence and is called elliptic flow.
A measurement of elliptic flow as a function of p_T and mass gives access to the properties of the Equation of State of the created system.

Flow Analysis Methods (A. M. Poskanzer, S. A. Voloshin: Phys. Rev. C**58**, 1671 (1998), N. Borghini, P. M. Dinh, J.-Y. Ollitrault: Phys. Rev. C**64**, 054901 (2001), R.S. Bhalerao, N. Borghini, J.-Y. Ollitrault: Nucl. Phys. **A**727, 373 (2003))

The flow signal has a contribution from *nonflow* particle correlations, caused by Bose-Einstein correlations (HBT), resonance decays and jet fragmentation.
By using analysis methods based on multi-particle correlations the nonflow contributions can be suppressed.
There are 3 basic analysis methods for measuring flow. In ALICE all these analysis methods will be used to do a systematic study of the elliptic flow signal.

Event plane method
Based on two-particle correlations.
+ Gives an estimate of the reaction plane.
– Is sensitive to nonflow correlations.
– Needs a correction for detector acceptance.

Cumulant method
Based on multi-particle correlations.
– Gives no reaction plane estimate.
+ Removes lower order nonflow correlations.
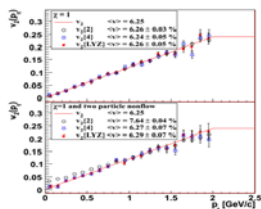+ Takes care of acceptance effects.

Lee-Yang Zeroes method
Correlates all particles in the event with each other.
+ Can give a reaction plane estimate.
+ Removes nonflow correlations.
+ Takes care of acceptance effects.

Comparison of the analysis methods using simulated data

28.000 Monte Carlo events with a total multiplicity M of 256.

Methods based on two-particle correlations (event plane method and second order cumulant) do not reproduce the elliptic flow when non-flow is present.

Lee-Yang Zeroes and higher order cumulants do reproduce the elliptic flow.

500 Monte Carlo events
(Therminator Nucl-th/0712.0947 W. Broniowski, M. Chojnacki, W. Florkowski, A. Kisiel).
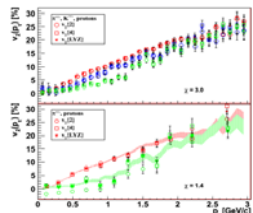
The Lee-Yang Zeroes and higher order cumulants are not affected by resonances while the two-particle correlation methods are.
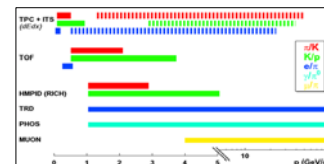
The ALICE Detector is well equipped for flow measurement

It covers a large rapidity range:

Midrapidity:
   TPC, ITS $|\eta|<0.9$
Forward rapidity:
   FMD $-3.4< \eta <-1.7$ & $1.7< \eta <5$
   PMD $1.8< \eta <2.6$
Beam rapidity:
   ZDC   z~50 m
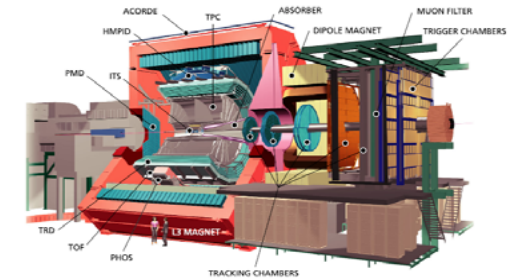
It has good PID capabilities:

It has good p_T and DCA resolution: